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Local value creation and eco-design: A new paradigm

Benjamin Tyl^{a*}, Iban Lizarralde^b, Romain Allais^c^a APESA, Technopole Izarbel, 64210 Bidart, France^b ESTIA Recherche, Technopole Izarbel, 64210 Bidart, France^c CREIDD, HETIC, ICD, Université de technologie de Troyes, UMR 6281, CNRS, Troyes, France* Corresponding author. Tel.: +33 5 59 51 83 06; fax: +33 5 59 51 83 03. E-mail address: benjamin.tyl@apesa.fr

Abstract

Design has a great role to play in sustainability. Interesting progresses has been performed within the last decades. Nevertheless, some issues of sustainability, and their impact on design, remains poorly studied. Specifically, when it comes to the field of local value creation, the literature in design is still limited. However, the Local Value Creation (LVC) thinking can be a great insight for designers to develop more eco-innovative concepts, through new product design, new services and new business models. In order to go towards this direction, it is necessary to include new variables that are rarely considered in design processes such as the local workforce, sustainable local resources or the customization of the new product or service for local customers.

This paper proposes a better understanding of the relation between eco-design approaches and LVC, and more precisely how current eco-design approaches consider this issue. To do so, a first part introduces the Local Value Creation concept and its challenges for sustainability. Then, a second part focuses on a literature review to understand how the LVC dimension is studied in the eco-design process. This will lead in a third section to concretely characterize how eco-design approaches and tools consider LCV issue. A last section proposes to identify potential contradiction between the LVC and the eco-design concept, in order to draw first outlines of a new eco-design paradigm with a Local Value Creation dimension.

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1. Local thinking and sustainable issue

Since the early industrial revolution, the business value creation factors slightly evolved from an industrial economy, through the optimization of production systems, to a market economy, through the minimization of production costs and marketing, and finally to a service economy, through a combination of high value services with low-cost goods [1]. Beside all the benefits it brought, the globalized economy, the mass consumption and the economic growth paradigms are major contributors to the current system crisis: environmental, social, economic or financial [2].

Environmental issues of globalized economy are mainly due to resource overconsumption and, to a lesser extent, to the

relocation of production to low wage countries with lower environmental and social standards (e.g. textile industry in Bangladesh). As a consequence, supply chains tend to grow longer and the international freight tends to intensify [3], [4] (see the well-known example of the 6000km traveled for a yoghurt pot [5]).

The constant extension of the supply chain leads to a dilution of the responsibility, even though more and more confidence is expected from users. Consequently, nowadays, working with suppliers and supply chain issues is an important strategic consideration [6]. In early industrialized countries, there is also a growing demand from consumers for the geographical origin of products and its traceability. The location of production has become one of the main criteria for

sustainable consumption. Moreover, local production often incorporates additional values in goods (e.g. environmental protection, fair trade, local sourcing).

From a strategically perspective and to meet its needs, territories must deal with the scarcity of primary material (such as iron or copper) and the availability of natural resources [7].

From a socio-economical perspective, localization of the production in low cost countries means, in a short term, losses of local employment in developed countries, a drop of product export and, in a medium term, the loss of mastery on production's techniques and a decrease the capacity to design or innovate [3]. These capability losses increase the vulnerability of territories in industrialized countries [4]. Moreover, emerging countries or regions of natural catastrophes may not have sufficient infrastructures (e.g. roads, water and energy supply) to start production activities that would ensure economic autonomy to go beyond daily struggle for survival. Thus, the challenge is to improve people's ability to meet their primary needs (i.e. food, clothes, health, and mobility) [8]. As one half of the world population lives without telephone and electricity, there is a legitimate claim for fair distribution of resources and access to wealth. In these cases, the objective is to provide local actors with easily and economically equipment, so "inexpensive, modular, easy to use and easy to maintain" [7]. Practical models of local manufacturing with limited resources (e.g. skills, tools, materials) could help building this local capability.

Thus, local approach has the potential to address sustainability challenges (i.e. increasing individual or community capability, efficient use of scarce resources etc.) in design through innovation.

1.1. The concept of "local" in literature

As a result of globalization crisis, new way of production and consumption, more focused on a local approach, have been studied and developed. Local is often associated to an emergent citizen's movement, the "localism movement" [9], which is looking for buying locally, independently from major companies.

But there is various research works and the mainly come from the economical sciences, with no clear definition. Johansson et al. [4] propose the concept of distributed economies (DE), as a way to develop regionally economy, with small-scale and flexible production units, in opposition to a more centralized economy with large scale production units. Frankova and Johanisova [10] worked on the concept of "economic localization". Through the analysis of several authors, they define it as "a support of as many localized aspects of production and consumption as possible". They also underline the need to develop local communities and democratic decision-making and they also integrate the economic localization within a moral and political thinking. In a same approach, Xue [11] consider that local economy includes "economic decisions at the local level". He underlines that the localization is not only for the production and consumption of goods, but also the relocalization of politics and decision making.

In a more design perspective, Manzini [12] introduce the "multi-local society" concept, as a network of "local systems". In other word, the local concept is embedded in a physical place, but connected other territories. A multi local society produce and consumes locally, "using to best advantage whatever is locally available", but in parallel exchanges with other territories "whatever cannot be locally produced".

Emerging from these propositions, we adopt in our research the concept of local value creation (LVC) which can be defined as "economic activities using locally available input flows and generating output flows for the local community". As a result, the definition of LVC shall include both the territorial and lifecycle perspectives. Designing a local product therefore consists in setting constraints (raw materials, needs, economics, human skills, etc.) in each physical area all along the lifecycle, from raw material extraction to end of life.

1.2. Main perspectives of Local Value Creation

A first essential dimension of the LVC is the definition of a geographic/physical scale. The reflection perimeter may be defined by two complementary approaches [1]. The first one 'administrative' consider business as an entity of a larger system. Existing administrative boundaries (i.e. region, country) may be considered for reflection. The second approach is centered on the business and considers its value creation system (i.e. stakeholders). In a CSR perspective, through the ISO 26000 norm, the value creation system encompasses both the creation and the destruction of value in the sphere of influence of the organization. This approach implies that the company's territory evolve with new partnerships. A first aim of the LVC is to minimize distances between value creation nodes.

A second essential perspective of LVC is to enable local value creation all along the life cycle of the product, with low environmental impacts, in line with an eco-design approach. As an illustration, the "made in France" label considers that a product is made in France as long as "the place where the product acquired its principal characteristics is located in France" and "more than 50% of the product costs are acquired in France". This definition therefore does not require that all the activities of the supply chain are located in France. One can ask the legitimacy of this label depending on what part of the value chain is considered.

From an environmental point of view, considering durability in local production further consists in setting constraints to the input and output materials (i.e. input material shall be locally available and renewable; output material shall be locally valorized until the end of life). Therefore, creating local value in this sense means creating value with short loops of materials. From a socio-economic point of view, local value creation requires use of local workforce and generation of valuable output for the community and therefore favors local employment, local ownership and local dynamism.

2. Integration of Local Value Creation issues in eco-design

In this part, we propose to identify first how “local value creation” is integrated in eco-design and more generally in sustainable design. Then, we consider some current eco-design and sustainable approaches through the LVC issues, in order to give new inputs and to enrich eco-design process.

2.1. State of the art

Eco-design is one of the first answers of companies to fulfill the emerging challenges of sustainable development. Eco-design is defined according to the international ISO 14 062 norm, as the integration of environmental constraints in the development process of product design. This approach relies on two main principles: a life cycle perspective and a multi-criteria approach. The life cycle perspective allows the consideration of the product or the service in the whole life cycle (raw materials, production, manufacture, distribution, use and end of life), whereas the multi-criteria approach considers the complexity of environment through different environmental impacts.

In academic literature, local issues and its impact on eco-design, and more generally on sustainable design, remains poorly studied. Amongst this literature, Manzini [13] introduces the notion of sustainable system characterized by low material-energy intensity and by a high degree of context quality, i.e. “it has to be tailored to fit the specific characteristics of the local context”. Recent work from Melles et al. [14] define some local criteria to characterize “socially responsible design”, i.e. design that go beyond sustainable design, such as the “relative affordability” (is the outcome locally and regionally affordable?), the advancement (does it create local or regional jobs and develop new skills?), the local control (can the solution be understood, controlled and maintained locally?) or the empowerment (does it empower the community to develop and own the solution?). Local issues have also an impact on the manufacturing process. As an example, shorten the process chain requires to reduce the material diversity, and to applying additive processes [7].

2.2. Local Value Creation challenges for eco-design

Considering local specific issues can offers great potential to eco-innovate. Local issues are a challenge in design, inviting design team and companies to reconsider the territorial and local dimension of the products and services.

Challenges are “physical”. Klewitz and Hansen [15] underlines that applying local sourcing and production paradigms, SMEs may radically remodel their supply chain. The result is an efficient supply chain (less steps, less warehousing, less transportation, packaging).

Challenges are also organizational. Allais et al. [1] highlight that the integration of territorial resources into product development process requires a deep evolution in strategic processes. They also underline that the use of both tangible and intangible territorial resources has the potential to improve the overall performance of a company and its territory [16].

In the specific scope of Sustainable Product Service System – i.e. an integrated system of products, services and socio-economical stakeholders [17], the local dimension is also a challenge. A PSS design is particularly focused on specifying the context of use, and need company involvement at the user location. In particular successful cases, some local stakeholders, such as governmental agencies, local administrations, providers, customers, plays a crucial role for the development of the PSS because they have specific knowledge for generating local solutions [18].

Thus, LVC challenges present potential contradictions with eco-design practices. A reason is that although eco-design is an already established field of research, it is still difficult to define what an eco-designed product is. How “eco” is the “design” is particularly related to geographic, temporal and cultural considerations. The case of the electric car offers an interesting illustration. Indeed, under specific circumstance, an electric car can be environmentally relevant, but can we still speak of an eco-designed car if it is used in a city with more sustainable alternatives for transport? An eco-designed product cannot be defined universally and intrinsically but in a sense extrinsic qualification related to particular contexts and associated uses. Lilley [19] underlines that the function of the product can only be justified including the framework within which the product is evolving. Thus, eco-design processes need to be based on local conditions; besides, specific approaches for sustainability need to be developed taking into account the local skills and competences [20].

3. Analysis of eco-design approaches and tools

In Sustainable design, a large variety of approaches, methods and tools have been analyzed and implemented [21], [22]. They offer designers a structured approach to integrate environmental criteria in the design process and they present different objectives. The following part briefly analyses the integration of LVC issue within four mains approaches: (1) a “Design for X” approach, (2) an eco-design and eco-innovation approach, (3) sustainable design approaches and (4) a Product Service System approach.

3.1. Design for X approaches (DfX)

DfX methods and techniques allow designers to include specific criteria when designing a new product or service. DfX literature is extensive and a complete recent state of the arte related to the sustainable aspects is presented in [23]. Some of DfX techniques integrate directly or indirectly LVC issues, such as the Design for Manufacture (DfM). Indeed, technical progress in digital manufacturing technologies and internet are changing classical manufacturing techniques from a mainstream approach to a coproduction or personal fabrication of goods [24]. DfM is been transformed by the emergence of new production means as additive manufacturing (AM) or the wide deployment of inexpensive 3D printing. The decentralization of little production units offers high local value manufacturing services. It enables the emergence of what Steffen [25] calls a neo-craftsmanship and

it result in a more efficient use of raw materials and energy [26]. To finish, personalization and mass customization integrate the customer deeper in the decision processes and increases the proximity between customer and “his/her” product. This leads to what Hu [27] calls personalized production, i.e. on-demand production of goods tailored to the customer’s needs through a co-creation process.

3.2. *Eco-design and eco-innovation approaches*

Eco-design and eco-innovation are widely supported by different methods and tools but few of them integrate a local approach. Some specific tools are focused on environmental assessment to assist designer’s choices in environmental product improvement, but few of them shares direct advice to integrate LVC in the product design. This advice generally consists in reducing logistic, and more rarely the use of local materials. Nevertheless, among these tools, the EcoDesign Pilot web tool [28] provides some strategies concerning local value creation. This tool proposes to “minimize transportation”, and specifically for transportation of materials and component, by “promoting the use of regionally available materials”. It also underlines that the use of local materials can realize regional value added. Concerning end-of-life issues, the tool guides the designer to consider real end-of-life context of product.

Some of these tools are specific to eco-innovation, such as EcoASIT [29], to help the generation of eco-innovative ideas. Considering this early stage of design, EcoASIT, an eco-ideation tool focusing on the idea generation, proposes to assess the referent system using a 5-axis evaluation diagram. Among these axes, one of them integrates the LCV approach: “The system participates in local dynamism”, such as “local employment, work condition, employment of ethnic minorities, new partnership, new activities creations and social cohesion”.

3.3. *Sustainable design approaches*

In addition to environmental issues, sustainable design approaches integrate the social aspect in the design process. The United Nations Environment Program (UNEP) recently developed a guideline for social LCA, or sLCA, an emerging topic in the LCA research community [30]. The objective is to assess social impacts of products during their lifecycle. Some result of sLCA concerns local stakeholders (local communities) and local categories (socio-economic repercussion). This is also the case of the method D4S (Design 4 Sustainability) [31]. This method, oriented on sustainable design, is based upon the D4S strategy wheel, an evaluation diagram around 8 axes, linked to potential D4S improvement strategies. This tool presents various strategies in line with local dimension of design. Some of them concern the use of local resources, promoting resources that have “a positive social impact, “generate local income”, or “increase the value added to local resources”). D4S method includes some strategies about the “local” end of life of the product, involving “local maintenance”, or taking into consideration “local collection/recycling systems”. The D4S also proposed

some principles that correspond to the notion of LVC (“increasing the share of added value benefits retained”, “increasing the diversity of collaboration among regional activities”). This work is in line with the Design for bottom-of-pyramid approach that promotes to design systems taking into account local context to improve the quality of life of under-developed communities [32].

3.4. *Product Service System approaches*

As previously said, a Product Service System is an integrated system of products, services and socio-economical stakeholders. PSS approach is closely linked to LVC. Tan [33] consider that companies need to develop local services to have knowledge on local customers and to be flexible with customized solutions. More recently, Buclet [34] proposes a 6-level typology for PSS that considers the territorial issues and the capability of individuals. Indeed, if the first four levels highlight organizational innovation implied by PSS (from selling the use instead of the product to offering a service based on the multimodality of the physical support provided to customers), the fifth level considers issues at the territorial scale, i.e. “offer a function to meet requirements at a territorial scale (e.g. mobility)”. The higher level considers a supplementary dimension with the empowerment of final user of the function: “co-design of a function (as well as the required physical media) between the producer and the customer/user, possibly by promoting local production of physical media”. He illustrates this level by the emergent trend of fab labs, living labs, etc.

Few tools and methods can support the design of PSS. One of them, the MEPSS tool [35], clearly indicates in its software a specific local-oriented guideline: “Empower/valorize local resource”. More recently, Jégou et al. [36] developed a PSS toolkit to design business models for PSS in an urban context. This toolkit is focused on a territorial approach to innovate on local solutions that meet local stakeholder’s needs.

4. *Local value creation: a new paradigm for eco-design*

The integration of LVC eco-design methods is a complex task. In order to towards this direction, it is necessary to include new variables that are rarely considered in design processes such as the local workforce, the sustainable local resources or the customization of the new product or service for local customers. The objective of this section is to identify new dimensions to guide the eco-design process toward local value creation. One of the possibilities is to question the local value creation dimension of a product/service, through “contradictions” in order to formalize a new eco-design paradigm.

4.1. *Local Value Creation versus life cycle thinking*

Short loops are often associated with industrial sectors that are not mobile, such as the agricultural sector; through for example the development of Community-supported agriculture practices. In this case, the production of fruits and vegetables is dependent of a territory. Rallet [37] defines this

situation as "a situation of geographical proximity constraint" often associated with the presence of available resources (e.g. soil, water etc.). The development of local products is easier, because production, consumption, and more generally the whole life cycle, can be done in the same geographical area.

This logic is different in the manufactured product scope, in a context of an increasing nomadism of companies [38]. If the manufacturing of a product can be guaranteed in a specific territory (in terms of origin of raw materials, assembly), the consumption of this product generally differs from the place of production. There is a contradiction between the different location during the lifecycle of the product and the local value target. This contradiction LVC/"Life cycle thinking" leads us to define the notion of "multi-local system", i.e. a system involved in various territories, which has to participate to the local dynamism of these territories. This notion is adapted from Buclet who define the "multi-local actor", i.e. an stakeholder involved within various territorial realities [39].

4.2. Local Value Creation versus economies of scale

One strategy to reduce production cost is to realize economies of scale by increasing the number of produced items and consequently the size of production units.

Economies of scale make also sense from an environmental point of view [40]. Schlich and Fleissner [41] considers that « the production ecology depends on the number of produced items ». He introduces the notion of « ecology of scale », that leads to a minimum business size to reduce the environmental impact. This means that the development of smaller and local production units may increase in some cases the environmental impacts.

But the optimum size of the production units is a complex topic. Indeed, the growing size of a production unit can have a systemic effect that counterbalances the potential benefits of the ecology of scale. Since the famous "Small is beautiful" from Schumacher's work [42], a lot of work have been done dealing with the size, the decentralization and collective control of industrial plants. As an example, Ludwig revisits Korh's effect of "diseconomies of scale" on sustainability [43]. He analyzes the issue of the optimum size from an environmental impact point of view considering the size, growth and concentration of business. Kohtala [24] examines the distributed production (DP) and argues that DP is not only a fact of scale, but it is also related to local characteristics and consumer-producer relationship. She identifies opportunities for a more sustainable production system but also warns about areas where undesired environmental impact may arise.

Lastly, scale and customization aspects have been investigated mainly in the literature related to mass customization. A small scale production does not necessarily mean a customized production and on the contrary, customization can be ensured in a mass level. Environment and societal benefits have been analyzed, identifying trade-offs linked to the customization and the scale of the production units [44]. Breaking through of this trade-offs goes by considering the local aspects early in the design process.

4.3. Local Value Creation versus global design

Eco-design considers whole life cycle of a product using multi-criteria approach and minimizes environmental impact for an accurate life cycle model. Each stage can be very different depending on the region. Instead of developing one global design solution for a global uniform market, designers have to understand and integrate into their design activities a very large range of different constraints and local characteristics. Product is adapted, makes sense for the local customers and minimizes environmental impact considering local characteristics. For example in a usage phase, the product can be adapted to the water availability of the region or the energy mix. But the customization strategy to fulfil customers' demands (e.g. mass customization) or target local needs is time and resources consuming. As consequences, if the company's organization remains the same, the cost structure of a real customized design (i.e. demand-driven design versus option-driven) will explode. Indeed, it implies that every customer have a specific product/service to fulfill its demand. This contradiction leads to the empowerment of local stakeholders that would become the designers of their own solution with their infrastructures, within an organization that can be supported by the emerging concept of Open Design. In this way, company could focus on a design of a product easy to be adapted to local skills and needs.

5. Conclusion

In this paper, the "Local Value Creation" approach is introduced as a new way to design sustainable systems and to revisit current system of production and consumption. It gives the possibility to a territory to fulfill its own need, to create sustainable added value for local stakeholders, and to increase the links between the different stakeholders of the value chain, beginning by the consumer. Moreover, it offers great potential to revisit and enrich the eco-design process and to design eco-innovative products. Through the analyses of eco-design tools and the identification of contradiction between LVC and mainstream eco-design approaches, this paper draw the first outlines of a new eco-design paradigm with a Local Value Creation dimension. This new paradigm may also reinforce the current PSS design strategies.

This work is a preliminary research, and various questions remain to study. In a theoretical point of view, all and eco-design approaches described in this paper must be stronger analyzed in order to find their strengths and the weaknesses according to LVC issue. Moreover, this paper particularly focuses on the inclusion of tangible territorial resources into design process but there is a large field of investigation to understand the potential benefits of the inclusion of territorial intangible resources, such as culture or local know-how into product design. Future work will focus on practical contribution. Indeed, the performance assessment of LVC implies the development of a set of indicator to evaluate the "LVC" of a product to complement the traditional environmental or economic assessment. A first work has been done for forest management [45]. Moreover, an adaptation of current design methods is needed to integrate LVC in the

whole design process, and more particularly in the earlier stages, to help designers to generate LVC-oriented concepts.

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